The Canonical Equations

Chapter VI

The Canonical Equations

\[ H[p,q] \]

The function of Hamilton's equations is to express the equations of motion in terms of the coordinates and momenta. The Hamiltonian function is given by

\[ H[p,q] = \sum \frac{p_i^2}{2m_i} + V(q) \]

The Hamilton's equations are

\[ \frac{dq_i}{dt} = \frac{\partial H}{\partial p_i} \]

\[ \frac{dp_i}{dt} = -\frac{\partial H}{\partial q_i} \]

These equations are the same as the Lagrange's equations when the Lagrangian is expressed in terms of the coordinates and momenta.

In the case of a system with a single degree of freedom, the equation of motion is given by

\[ m \ddot{q} = -\frac{\partial V}{\partial q} \]

where \( V \) is the potential energy of the system.

For a system with two degrees of freedom, the equations of motion are

\[ m_1 \ddot{q}_1 = -\frac{\partial V_1}{\partial q_1} - \frac{\partial T}{\partial q_1} \]

\[ m_2 \ddot{q}_2 = -\frac{\partial V_2}{\partial q_2} - \frac{\partial T}{\partial q_2} \]

where \( T \) is the kinetic energy of the system.
\[ J = \sum_{i} \left( \frac{1}{2} p_i^2 + V(x) \right) = H \]

Hence, \( J + H = \mathcal{H} \) is the Hamiltonian, where \( J \) and \( H \) are the total angular momentum and the total Hamiltonian, respectively.

In coordinate space, the Hamiltonian is given by

\[ \mathcal{H} = \sum_{i} \left( \frac{p_i^2}{2m} + V(x_i) \right) \]

Where \( m \) is the mass of the particle and \( V(x_i) \) is the potential energy at position \( x_i \).

The Hamiltonian operator in momentum space is given by

\[ H = -\frac{\hbar^2}{2m} \nabla^2 + V(x) \]

Where \( \hbar \) is the reduced Planck constant.

Problems:

1. Find the time derivative of the Hamiltonian in coordinate space.
2. Find the time derivative of the Hamiltonian in momentum space.
3. What is the difference between the two expressions for the Hamiltonian?

The Concluded Equations

133
\[
\left[ \frac{\partial}{\partial x} \right]^2 + \left[ \frac{\partial}{\partial y} \right]^2 = \left[ \frac{\partial}{\partial \theta} \right]^2 + \frac{m}{\ell^2}
\]

Taking the partial derivative of \(\phi\) with respect to \(\theta\) and setting \(\phi = \theta\) we obtain

\[
\left[ \frac{\partial}{\partial x} \right] \phi + \left[ \frac{\partial}{\partial y} \right] \phi = \left[ \frac{\partial}{\partial \theta} \right] \theta + \frac{m}{\ell^2}
\]

Since \(? = \phi\)

\[
\phi = \theta
\]

\[
\left[ \frac{\partial}{\partial \theta} \right] \theta = \theta
\]

The function is a constant. If \(\phi\) is zero, if the two functions are independent, the bracket diagrams show the one of the Poisson brackets the following properties, which are easy to deduce

\[
\left\{ \frac{\partial}{\partial x}, \frac{\partial}{\partial y} \right\} = \left\{ \frac{\partial}{\partial \theta}, \frac{\partial}{\partial \theta} \right\}
\]

To any two quantities \(f\) and \(\phi\), the Poisson bracket is defined as

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

If the integral of the motion is not explicitly dependent on the time, then

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)

\[
\left\{ \frac{\partial}{\partial \theta} \right\} \frac{\partial}{\partial x} = \left( \frac{\partial}{\partial \theta} \right) \frac{\partial}{\partial x} = \left( \frac{\partial}{\partial \theta} \right) \frac{\partial}{\partial x} = \frac{\partial}{\partial x}
\]

According to the general definition of the flow of the system is

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

Substituting these equations in the Lagrangian with the coordinates we have

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

Hence

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The Hamiltonian with respect to the coordinates

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

In terms of the Hamiltonian it is

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)

\[
\{ f, \phi \} = \left( \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} - \frac{\partial f}{\partial \phi} \frac{\partial \phi}{\partial \phi} \right)
\]

The expression is called the Poisson bracket of the quantities \(f\) and \(\phi\)
The canonical form of the general form of the inverse of the derivative of the second derivative can be written in terms of two

\[
\left(\frac{df}{dp}\right)^2 + \left(\frac{df}{p}\right)^2 = \left(\frac{df}{p}\right)^2
\]

and the difference of these

\[
\frac{\partial \phi}{\partial \psi} \cdot \frac{\partial \psi}{\partial \phi} = \phi^2 - \psi^2
\]

where \(\phi\) and \(\psi\) are arbitrary functions of the variables \(x, y, z, \ldots\).

Then

\[
0 = \sum \frac{\partial \phi}{\partial \psi} \cdot \frac{\partial \psi}{\partial \phi} = \phi^2 - \psi^2
\]

Operations in terms of Jacobians are

\[
\frac{d^2 \phi}{d\psi^2} - \left(\frac{d\phi}{d\psi}\right)^2 = \left(\frac{d\phi}{d\psi}\right)^2
\]

In order to include the second derivative of the second derivative of the function \(f\), we have to introduce the second derivative of the second derivative of \(f\), which is a higher order differential of \(f\). However, the second derivative of the second derivative of \(f\) is still of the same form as the first derivative of \(f\). According to the definition of the second derivative of \(f\), the second derivative of \(f\) is a higher order differential of \(f\). Therefore, the position of the function \(f\) is not defined. The position of the function \(f\) is not defined.

\[
\phi = \psi + \phi_1
\]

for all \(\phi_1\).

Thus, the position of the function \(f\) is not defined. The position of the function \(f\) is not defined.
The action as a function of the co-ordinates

\[ \mathcal{T} = \int L \, dt \]

which is the action integral, is the integral of the action over a path in phase space. The action is a functional of the field and a functional of time, and it is defined as the integral of the Lagrangian over the time interval. The Lagrangian is a function of the field and its time derivatives, and it is related to the Hamiltonian of the system through the principle of least action.

\[ L = T - V \]

where \( T \) is the kinetic energy and \( V \) is the potential energy. The Lagrangian is a fundamental quantity in classical mechanics and field theory.

The action is a measure of the total energy of the system over a given path. It is a key concept in the formulation of the principle of least action, which states that the actual path taken by a system is the one that minimizes the action under given initial and boundary conditions.

\[ \frac{\partial L}{\partial q_i} = \frac{\partial \mathcal{T}}{\partial \dot{q}_i} \]

This is the equation of motion derived from the principle of least action. It is a necessary condition for the path to be a stationary point of the action. The Euler-Lagrange equation is a direct consequence of the principle of least action and is a fundamental equation in classical mechanics.

\[ \frac{\partial L}{\partial q_i} - \frac{d}{dt} \frac{\partial L}{\partial \dot{q}_i} = 0 \]

This is the Euler-Lagrange equation, which is a differential equation that describes the motion of the system. It is derived from the principle of least action and is a key equation in classical mechanics.

The action principle is a powerful tool in physics, allowing the formulation of a wide range of physical theories, including classical mechanics, field theory, and quantum mechanics. It provides a unifying framework for the description of physical systems and is a cornerstone of modern theoretical physics.
The functional equation of the motion of a mechanical system is of the form:

\[ \frac{\partial}{\partial t} \frac{\partial H}{\partial \dot{q}} - \frac{\partial}{\partial q} \frac{\partial H}{\partial \ddot{q}} = 0. \]

This equation expresses the conservation of energy. The Hamiltonian \( H \) is a function of the generalized coordinates \( q \) and \( \dot{q} \), and the partial derivatives with respect to \( q \) and \( \dot{q} \) give the forces and moments acting on the system.

The equation of motion is derived by applying the Euler-Lagrange equations, which state that the variation of the Lagrangian \( L = T - V \) with respect to the coordinates and their derivatives yields the equations of motion:

\[ \delta \int L dt = 0. \]

The action principle states that the actual path taken by the system is such that the action is stationary. This means that the variation of the action is zero for any small displacement of the path.

We can express the action in terms of the Lagrangian:

\[ S = \int L dt = \int \left( \frac{1}{2} \dot{q}^2 - V \right) dt. \]

The principle of least action is used to find the path that minimizes the action, which corresponds to the equilibrium of the system.

The Hamilton's equations can be derived from the Lagrangian by using the Legendre transformation:

\[ \dot{q} = \frac{\partial H}{\partial \dot{q}} \quad \dot{p} = -\frac{\partial H}{\partial q}. \]

These equations express the dynamics of the system in terms of the conjugate momenta \( \dot{p} \) and the coordinates \( q \).

The study of these properties forms a part of the subject of geometric mechanics.
we obtain the differential equation of the form

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]

Substituting the values, we have

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]

which is the solution of the differential equation.

**Problem**

The path is entirely determined by the motion, which is just the integral of equation (9.14) together with the equation of motion:

\[
\frac{d^2}{d\theta^2} = \frac{d}{d\theta} \left( \sqrt{(\lambda - 3)^2 + 4} \frac{d\theta}{d\theta} \right)
\]

When the described motion has the form (9.9), this gives

\[
\frac{d^2}{d\theta^2} = \frac{d}{d\theta} \left( \sqrt{(\lambda - 3)^2 + 4} \frac{d\theta}{d\theta} \right)
\]

Substituting in (9.44), we obtain

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]

with the integral (9.12) gives the total result.

Let us return now to the expression (9.43) for the action and verify it with Gauss points. It is the particle moves along the shortest path between the two points in the space of the action. When the integral is taken between two given points in space, this form is

\[
\int_0^1 \sqrt{(\lambda - 3)^2 + 4} \frac{d\theta}{d\theta}
\]

which is the mass of the particle and expression of the path the variational principle, which determines the path is

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]

In particular, for a single particle, the kinetic energy is

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]

Expanding the determinant in the determinant and writing the force F = dp/d\theta gives

\[
\frac{dp}{d\theta} = \frac{\sqrt{(\lambda - 3)^2 + 4}}{\sqrt{\lambda}}
\]
The Hamilton-Jacobi equation is used to derive the Hamilton-Jacobi equation, which must be satisfied by the function \( S(q, p, t) \). The most general form of the Hamilton-Jacobi equation is given by:

\[
0 = \left( \frac{\partial S}{\partial q} \right)_p \left( \frac{\partial S}{\partial p} \right)_q + \frac{1}{2} \nabla^2 S + \mathcal{H} \tag{14.47}
\]

The Hamilton-Jacobi equation is a first-order partial differential equation that is derived from the Hamiltonian function. The equation is used to find the classical trajectories of a system.

The Hamilton-Jacobi equation is a powerful tool for solving the equations of motion for a system. It allows us to find the classical trajectories of a system by solving a first-order partial differential equation. The equation is given by:

\[
\frac{\partial S}{\partial t} + \mathcal{H} = 0 \tag{14.48}
\]

The Hamilton-Jacobi equation is a first-order partial differential equation that is derived from the Hamiltonian function. The equation is used to find the classical trajectories of a system.

Another property of the Hamilton-Jacobi equation is that it is a function of the momentum and the Hamiltonian. This property is given by:

\[
\frac{\partial S}{\partial p} = \mathcal{H} \tag{14.49}
\]

We will use this property of the Hamilton-Jacobi equation to solve the equations of motion for a system.

We consider the transformation of the Hamiltonian in a new coordinate system. The transformation of the Hamiltonian is given by:

\[
\mathcal{H}' = \mathcal{H} + \frac{\partial S}{\partial t} \tag{14.50}
\]

The Hamilton-Jacobi equation is a powerful tool for solving the equations of motion for a system. It allows us to find the classical trajectories of a system by solving a first-order partial differential equation. The equation is given by:

\[
\frac{\partial S}{\partial t} + \mathcal{H} = 0 \tag{14.48}
\]

The Hamilton-Jacobi equation is a first-order partial differential equation that is derived from the Hamiltonian function. The equation is used to find the classical trajectories of a system.

Another property of the Hamilton-Jacobi equation is that it is a function of the momentum and the Hamiltonian. This property is given by:

\[
\frac{\partial S}{\partial p} = \mathcal{H} \tag{14.49}
\]

We will use this property of the Hamilton-Jacobi equation to solve the equations of motion for a system.

We consider the transformation of the Hamiltonian in a new coordinate system. The transformation of the Hamiltonian is given by:

\[
\mathcal{H}' = \mathcal{H} + \frac{\partial S}{\partial t} \tag{14.50}
\]

The Hamilton-Jacobi equation is a powerful tool for solving the equations of motion for a system. It allows us to find the classical trajectories of a system by solving a first-order partial differential equation. The equation is given by:

\[
\frac{\partial S}{\partial t} + \mathcal{H} = 0 \tag{14.48}
\]

The Hamilton-Jacobi equation is a first-order partial differential equation that is derived from the Hamiltonian function. The equation is used to find the classical trajectories of a system.

Another property of the Hamilton-Jacobi equation is that it is a function of the momentum and the Hamiltonian. This property is given by:

\[
\frac{\partial S}{\partial p} = \mathcal{H} \tag{14.49}
\]

We will use this property of the Hamilton-Jacobi equation to solve the equations of motion for a system.

We consider the transformation of the Hamiltonian in a new coordinate system. The transformation of the Hamiltonian is given by:

\[
\mathcal{H}' = \mathcal{H} + \frac{\partial S}{\partial t} \tag{14.50}
\]

The Hamilton-Jacobi equation is a powerful tool for solving the equations of motion for a system. It allows us to find the classical trajectories of a system by solving a first-order partial differential equation. The equation is given by:

\[
\frac{\partial S}{\partial t} + \mathcal{H} = 0 \tag{14.48}
\]

The Hamilton-Jacobi equation is a first-order partial differential equation that is derived from the Hamiltonian function. The equation is used to find the classical trajectories of a system.
We seek a solution in the form of a function:

\[ \psi = \frac{1}{2} \left( \frac{d}{dx} + \frac{d}{dy} \right) S = S \]

where \( \phi \) denotes all co-ordinates except \( n \).

The form of the equation is given by:

\[ 0 = \left( \frac{1}{dS/n} \right) \frac{d}{dx} + \left( \frac{1}{dS/n} \right) \frac{d}{dy} \]

of derivatives, is the equation of the motion, which does not introduce the co-ordinates, the

Joung's equation can be found by separating the variables, a name given to

In a number of important cases, a complete integral of the Hamilton–

\[ J = \int \phi \theta \, dS/n \]

\[ \mathcal{E} = \frac{1}{2} \int \left( \frac{d}{dx} + \frac{d}{dy} \right)^2 S = S \]

\[ \frac{d}{dx} - \left( \frac{dS/n}{\theta} \right) \frac{d}{dy} = S \]

The Hamilton–Joung equation takes a similar form as the time-

The time-depending of the action is given by a term. By a term,

The Hamilton–Joung equation takes a complete integral form if the function

\[ \nu = \frac{1}{2} \int \left( \frac{d}{dx} + \frac{d}{dy} \right)^2 S = S \]

\[ \frac{d}{dx} + \left( \frac{dS/n}{\theta} \right) \frac{d}{dy} = S \]

The derivatives in new co-ordinates, we obtain the co-ordinate equation

Differentiation with respect to the Hamiltonian changes the Hamilton–

This is the solution of the equation of motion of a mechanical system.
The most powerful method of finding the general integral of the equation of motion is the Hamilton–Euler Hamiltonian method. The Hamilton–Euler equations are:

\[ \frac{\partial H}{\partial \dot{q}_i} = \frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{q}_i} \]

\[ \frac{\partial H}{\partial q_i} = -\frac{d}{dt} \frac{\partial \mathcal{L}}{\partial \dot{q}_i} \]

where \( H \) is the Hamiltonian, \( q_i \) are the generalized coordinates, and \( \dot{q}_i \) are their time derivatives. The function \( \mathcal{L} \) is the Lagrangian, which is given by:

\[ \mathcal{L} = T - U \]

where \( T \) is the kinetic energy and \( U \) is the potential energy of the system.

\[ \mathcal{L} = \frac{1}{2} m \dot{q}^2 - V(q) \]

The Hamiltonian is:

\[ H = \sum_i \left( \frac{1}{2} m_i \dot{q}_i^2 - V(q_i) \right) \]

For the system to be completely isolated, the total energy is constant:

\[ \frac{dH}{dt} = 0 \]

This is known as the Hamilton's equations of motion.

In this context, the Hamilton–Euler equations correspond to the classical Hamiltonian equations of motion.

The Hamilton–Euler equations are a powerful tool in classical mechanics, providing a way to describe the evolution of a system in terms of its generalized coordinates and momenta. They are equivalent to the Lagrange equations but offer a different perspective, allowing for a more direct application to problems in classical mechanics.
The physically interesting cases of separable variables correspond to
\[ \left(\phi \mu \phi\right)_N = \frac{\phi\mu(\phi - 1) + I(1 - \phi)}{I} \]
and
\[ \left(\phi \mu \phi\right)_1 = \frac{\phi\mu(\phi - 1) + I(1 - \phi)}{I} \]
The Hamiltonian is then
\[ \frac{\phi + 3}{\phi + 3} + \frac{\phi + 3}{\phi + 3} = \frac{\phi + 3}{\phi + 3} \]
The physically interesting cases of separable variables in these- coordin.
\[ S - 1 = \frac{\phi\mu(\phi - 1) - I(1 - \phi)}{I} \]
The momenta are
\[ \phi' [\mu + 3] = \frac{\phi\mu(\phi - 1) + I(1 - \phi)}{I} \]
we obtain
\[ (\phi \mu \phi)(\phi + 3) + \phi\mu(\phi - 1) + I(1 - \phi) = S \]
the integrals in cylindrical coordinates, as
\[ (\phi \mu \phi)(\phi + 3) + \phi\mu(\phi - 1) + I(1 - \phi) = S \]
the integrals of the equations can also be written
\[ (9.64) \quad \frac{d\theta}{d\theta} + \frac{b}{b} = \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]

The expression on the right side of the equation which would occur if & were combined, and in the function \( \theta \) being away from zero, we can neglect only \( b \) and \( b \) and

\[ \frac{d\theta}{d\theta} \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]

the expression on the right side of the equation which would occur if & were combined, and in the function \( \theta \) being away from zero, we can neglect only \( b \) and \( b \) and

\[ \frac{d\theta}{d\theta} \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]

the expression on the right side of the equation which would occur if & were combined, and in the function \( \theta \) being away from zero, we can neglect only \( b \) and \( b \) and

\[ \frac{d\theta}{d\theta} \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]

the expression on the right side of the equation which would occur if & were combined, and in the function \( \theta \) being away from zero, we can neglect only \( b \) and \( b \) and

\[ \frac{d\theta}{d\theta} \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]

the expression on the right side of the equation which would occur if & were combined, and in the function \( \theta \) being away from zero, we can neglect only \( b \) and \( b \) and

\[ \frac{d\theta}{d\theta} \frac{d\theta}{d\theta} = \frac{d\theta}{d\theta} \]
The variables $\mathbf{f}$ and $\mathbf{g}$ are called canonical coordinates. The action $I$ is defined by $I = \int L dt$, where $L$ is the Lagrangian of the system.

$\frac{d}{dt} (\mathbf{f} \cdot \mathbf{g}) = \mathbf{g} \cdot \frac{\partial L}{\partial \mathbf{f}} - \mathbf{f} \cdot \frac{\partial L}{\partial \mathbf{g}}$.

For the potential energy $V$, the Hamiltonian is $H = \mathbf{f} \cdot \frac{\partial L}{\partial \mathbf{g}} - \mathbf{g} \cdot \frac{\partial L}{\partial \mathbf{f}}$.

The integral of the action over the complete range of $t$ from $0$ to $T$ is the Hamiltonian $H$.
The equation of motion (50.10) and (50.11) enables us to consider the

\[ 0 = \gamma \left( \frac{V}{V_e} \right) - \frac{I}{I_e} \]

as we have observed, the mean value (see the figure above) of the function \( \gamma \), which is the portion of the derivative of the function \( \gamma \) with respect to the function \( \lambda \), is a function of \( \delta \). Hence, we can express the function \( \gamma \) as a function of \( \delta \). The function \( \gamma \) is a function of \( \delta \), since the derivative of \( \gamma \) is a function of \( \delta \). Therefore, the equation of motion in the form (50.10) allows a further elucidation when the function \( \gamma \) is a function of \( \delta \).

**Accuracy of Convergence of the Differential Equation**

\[ \gamma \left( \frac{V}{V_e} \right) + \frac{I}{I_e} = 0 \]

and

\[ \gamma \left( \frac{V}{V_e} \right) - \frac{I}{I_e} = 0 \]

consequently, the equations (50.10) and (50.11) become

\[ \gamma \left( \frac{V}{V_e} \right) = \frac{I}{I_e} \]

In this case, the equation of motion in the form (50.10) and (50.11) becomes

\[ \gamma \left( \frac{V}{V_e} \right) - \frac{I}{I_e} = 0 \]

where the terms of the equation are expressed in terms of the function \( \gamma \). The function \( \gamma \) is a function of \( \delta \), since the derivative of \( \gamma \) is a function of \( \delta \). Therefore, the equation of motion in the form (50.10) allows a further elucidation when the function \( \gamma \) is a function of \( \delta \).

**Problem**

When \( \gamma \) is the oscillation frequency, then the equation (50.10) is given by

\[ \gamma \left( \frac{V}{V_e} \right) + \frac{I}{I_e} = 0 \]

and

\[ \gamma \left( \frac{V}{V_e} \right) - \frac{I}{I_e} = 0 \]

With the substitution of the function \( \gamma \) in terms of \( \delta \), the equation (50.10) becomes

\[ \gamma \left( \frac{V}{V_e} \right) - \frac{I}{I_e} = 0 \]

The function \( \gamma \) is a function of \( \delta \), since the derivative of \( \gamma \) is a function of \( \delta \). Therefore, the equation of motion in the form (50.10) allows a further elucidation when the function \( \gamma \) is a function of \( \delta \).
\[
\frac{d}{dy} \left( \frac{d}{dy} \phi \right) = \frac{d}{dy} \left( \frac{d}{dy} \phi \right) = f(y) \quad \text{(15)}
\]

The integral of \((15)\) with respect to \(y\) is:
\[
\int f(y) \, dy = \phi \quad \text{(16)}
\]

Then, the antiderivative of \(f(y)\) is given by:
\[
\frac{d}{dy} \left( \frac{d}{dy} \phi \right) = f(y) \quad \text{(17)}
\]

The constant term \(c\) in the function \(\phi(y)\) is determined by the initial conditions of the problem. This is because the constant term is the only term left when the derivative of the function is zero:
\[
f(y) = 0 \quad \text{for some values of } y
\]

The function \(f(y)\) is a periodic function of \(y\), with period \(2\pi\), and it satisfies the boundary conditions:
\[
\phi(0) = \phi(2\pi) = 0 \quad \text{(18)}
\]

The integral of \(f(y)\) over one period is:
\[
\int_0^{2\pi} f(y) \, dy = 0
\]

The function \(f(y)\) is continuous and bounded on the interval \([-\pi, \pi]\), and it satisfies the boundary conditions:
\[
\phi(-\pi) = \phi(\pi) = 0
\]

Therefore, the antiderivative of \(f(y)\) is:
\[
\frac{d}{dy} \left( \frac{d}{dy} \phi \right) = f(y) \quad \text{(19)}
\]

The integral of \(f(y)\) over one period is:
\[
\int_{-\pi}^{\pi} f(y) \, dy = 0
\]

The function \(f(y)\) is continuous and bounded on the interval \([-\pi, \pi]\), and it satisfies the boundary conditions:
\[
\phi(-\pi) = \phi(\pi) = 0
\]
Continuously Periodic Motion

The canonical equations of motion are shown by the fact that the action is constant.

\[ S = \int L dt \]

where \( L \) is the Lagrangian of the system.

The action is the path integral over the action of each coordinate function.

Two separate problems arise when the action is not constant, in the presence of a total derivative. The motion is then described by the action of each coordinate function.

These equations of motion are the result of a path integral over the action of each coordinate function.

The Hamilton-Jacobi equation is the equation of motion for a system with a constant action. The solution of the Hamilton-Jacobi equation is the equation of motion for a system with a constant action.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.

The Hamilton-Jacobi equation is a partial differential equation that describes the evolution of a system in phase space. The solutions of the Hamilton-Jacobi equation are the trajectories of the system.
\[165\]
The Hamiltonian 

\[ H = \frac{p^2}{2m} + V(x) \]

represents the total energy of a system. Here, \( p \) is the momentum operator, \( m \) is the mass of the particle, and \( V(x) \) is the potential energy. The Schrödinger equation, which describes the time evolution of the wave function \( \psi(x,t) \), is given by

\[ i\hbar \frac{\partial \psi}{\partial t} = H \psi \]

where \( \hbar \) is the reduced Planck constant. In the context of quantum mechanics, the Hamiltonian is the operator that represents the total energy of the system, and the Schrödinger equation is the fundamental equation of quantum mechanics, from which all other quantum mechanical phenomena can be derived.